MS-ESS1-1 Earth's Place in the Universe

Students who demonstrate understanding can:

MS-ESS1-1. **Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena.

Disciplinary Core Ideas

ESS1.A: The Universe and Its Stars

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

ESS1.B: Earth and the Solar System

- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause-and-effect relationships.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Observable features of the student performance by the end of the course:		
1	Components of the model	
	a	To make sense of a given phenomenon, students develop a model (e.g., physical, conceptual, graphical) of the Earth-moon-sun system in which they identify the relevant components, including:
		i. Earth, including the tilt of its axis of rotation.
		ii. Sun.
		iii. Moon.
		iv. Solar energy.
	b	Students indicate the accuracy of size and distance (scale) relationships within the model, including any scale limitations within the model.
2	Relationships	
	a	In their model, students describe the relationships between components, including:
		i. Earth rotates on its tilted axis once an Earth day.
		ii. The moon rotates on its axis approximately once a month.
		iii. Relationships between Earth and the moon:
		1. The moon orbits Earth approximately once a month.
		2. The moon rotates on its axis at the same rate at which it orbits Earth so that the side of the moon that faces Earth remains the same as it orbits.
		3. The moon's orbital plane is tilted with respect to the plane of the Earth's orbit around the sun.
		iv. Relationships between the Earth-moon system and the sun:
		1. Earth-moon system orbits the sun once an Earth year.

		2. Solar energy travels in a straight line from the sun to Earth and the moon so that the side of Earth or the moon that faces the sun is illuminated.
		3. Solar energy reflects off of the side of the moon that faces the sun and can travel to Earth.
		4. The distance between Earth and the sun stays relatively constant throughout the Earth's orbit.
		5. Solar energy travels in a straight line from the sun and hits different parts of the curved Earth at different angles — more directly at the equator and less directly at the poles.
		6. The Earth's rotation axis is tilted with respect to its orbital plane around the sun. Earth maintains the same relative orientation in space, with its North Pole pointed toward the North Star throughout its orbit.
3	Connections	
	a	Students use patterns observed from their model to provide causal accounts for events, including:
		i. Moon phases:
		1. Solar energy coming from the sun bounces off of the moon and is viewed on Earth as the bright part of the moon.
		2. The visible proportion of the illuminated part of the moon (as viewed from Earth) changes over the course of a month as the location of the moon relative to Earth and the sun changes.
		3. The moon appears to become more fully illuminated until "full" and then less fully illuminated until dark, or "new," in a pattern of change that corresponds to what proportion of the illuminated part of the moon is visible from Earth.
		ii. Eclipses:
		1. Solar energy is prevented from reaching the Earth during a solar eclipse because the moon is located between the sun and Earth.
		2. Solar energy is prevented from reaching the moon (and thus reflecting off of the moon to Earth) during a lunar eclipse because Earth is located between the sun and moon.
		3. Because the moon's orbital plane is tilted with respect to the plane of the Earth's orbit around the sun, for a majority of time during an Earth month, the moon is not in a position to block solar energy from reaching Earth, and Earth is not in a position to block solar energy from reaching the moon.
		iii. Seasons:
		1. Because the Earth's axis is tilted, the most direct and intense solar energy occurs over the summer months, and the least direct and intense solar energy occurs over the winter months.
		2. The change in season at a given place on Earth is directly related to the orientation of the tilted Earth and the position of Earth in its orbit around the sun because of the change in the directness and intensity of the solar energy at that place over the course of the year.
		a. Summer occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted toward the sun. Summer occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted toward the sun.
		b. Winter occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted away from the sun. Summer occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted away from the sun.
	b	Students use their model to predict:
		i. The phase of the moon when given the relative locations of the Earth, sun, and moon.
		ii. The relative positions of the Earth, sun, and moon when given a moon phase.
		iii. Whether an eclipse will occur, given the relative locations of the Earth, sun, and moon and a position on Earth from which the moon or sun can be viewed (depending on the type of eclipse).
		iv. The relative positions of the Earth, sun, and moon, given a type of eclipse and a position on Earth from which the moon/sun can be viewed.